

EFFECT OF DISTRIBUTION OF VENTILATION ZONE COVERAGE BY LIPS ON TAR YIELDS

Full Flavor Yield (% Smokers)	Lights Yield (% Smokers)	Ultra Light (% Smokers)
11.9 (48)	6.7 (64)	2.2 (55)
12.0 – 12.4 (43)	6.8 – 7.2 (22)	2.3 – 2.7 (13)
12.5 – 12.9 (5)	7.3 – 7.7 (10)	2.8 – 3.2 (11)
		3.3 – 3.7 (7)



MEASUREMENT BASED ON "CO BOOST"

- "CO Boost" is the increase in CO in the exhaled air of the smoker immediately after taking one puff compared to immediately before smoking
- Results indicate 50% is all that can be blocked with the lips, consistent with Röper's image analyses



SUMMARY

- Butt stain patterns indicate only 4% completely blocked; <29% partial. Butt stain patterns can only be used to determine blocking or no-blocking, not extent.
- What subjects do and what they think they do are quite different
- Only 11% of 133 British subjects had their fingers in contact with the cigarette during one or more puffs of the smoking cycle.



SUMMARY (cont.)

- Insertion depths range from 3 – 25 mm, with a mean of 10.1 – 11mm.
- Complete blockage of the ventilation zone of the lowest yield cigarettes results in a 5-fold increase in TPM. This is “clearly massive” in comparison to the TPM yields obtained for partial blocking that occurs in practice for some smokers



A Review

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OBJECTIVE

- Share knowledge on vent hole blocking with CE
- Provide information needed for decision-making in future studies



SOURCE FOR THIS PRESENTATION

- "Filter Ventilation—Has There Been a Cover-up?" by Richard Baker (BAT) and Leslie Lewis (RJR) presented at 1997 TCRC (invited Symposium talk); published in Recent Advances in Tobacco Science
- Review, not critique, of this paper
- Includes published and unpublished results



BACKGROUND

- Filter ventilated cigarettes introduced in 1960s to reduce yields
- In addition to smoke dilution, filter ventilation affects combustion processes, particulate filtration, and gaseous diffusion



BACKGROUND (cont.)

"Since the early 1960s a number of studies . . . have been interpreted to imply that more than 50% of smokers of ventilated cigarettes block the ventilation holes. . ."




PUBLISHED LITERATURE

- Kozlowski (Dept. of Behavioral Health, Penn State) most prolific
- Kozlowski anecdote
- Three categories
 - Methodology
 - Incidence
 - Effect on smoke yields



PUBLISHED LITERATURE: METHODS

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KOZLOWSKI PUBLICATIONS ON METHODS (1980)

- Visual, "after-the-fact"
 - Lipstick stain on the filter
 - Filter-end staining pattern
 - Bull's eye indicates no blocking
 - Heavy stain across entire filter indicates blocking
 - Light stain across entire filter indicates partial blocking
- Interviews indicated "32—69% of low tar smokers have blocked ventilation holes"
 - <4 mg tar yield Canadian cigarettes
 - FDA

KOZLOWSKI PUBLICATIONS ON METHODS

- Second Kozlowski study (1982)
 - 46 smokers observed
 - Period of observation not known
 - Compared observation of smoking event with filter staining patterns:
 - 39 evaluable subjects
 - 4% probably not blocked, 44% partially blocked but "impossible to judge with any confidence"; 15% "probably blocked very effectively; 37% not accounted for in paper

LOMBARDO PUBLICATIONS ON METHODS

- Lombardo et al. (1983)
- Investigation of accuracy of raters and comparison of human smoked cigarettes and machine smoked cigarettes

<u>Condition</u>	<u>Correctly Rated</u>
Unblocked	79%
Partially blocked	52%
Completely blocked	90%



LOMBARDO PUBLICATIONS ON METHODS

- Lombardo et al. concluded that Kozlowski's 39—69% of smokers blocking may be too small, but added that “[i]t is possible that, even with trained raters, the detection of ventilation hole blocking in smokers may prove *too* unreliable to be useful” (emphasis in original)

ZACNY AND STITZER PUBLICATION ON METHODS

- Zacny and Stitzer, 1988
- 10 smokers, "high-yield" cigarette smokers; forced switching in random order to 4 similar pressure drop cigarette brands yielding 0.1 to 1.1 mg smoke nicotine (FTC)

ZACNY AND STITZER PUBLICATION ON METHODS

- Could not distinguish (with the four stain categories) between unblocked and partially blocked vents for 0.4 to 0.7 mg nicotine yield cigarettes
- 1600 returned butts from the 0.1 mg brand

Completely blocked	0.1%
Partially blocked	6%
Questionable	22%
Unblocked	72%



KOZLOWSKI PUBLICATIONS ON METHODS (1988)


- Collected ~1000 butts from public ashtrays in Toronto
- Sorted into 135 filters of "low-yield" (FTC tar \leq 4mg)

Extremely blocked	19%
Partially blocked	39%
Unblocked	42%



KOZLOWSKI PUBLICATIONS ON METHODS (1989)

- 14 ultra-low tar smokers
- Smoked on-site
- 50% reported to have blocked at least some of the vents; 21% considered complete
- 86% said they never blocked the vents
- 2 smokers who self-identified as blockers were not observed to do so




KOZLOWSKI PUBLICATIONS ON METHODS (1994)

- Pillitteri first author
- Filter stain methodology
- Cigarettes of 9 – 12 mg tar; machine smoked unblocked, 50% blocked; 100% blocked; and first 5 puffs 50% blocked and second 5 puffs completely blocked
- Three best raters agreed 91.7% of the time for light cigarettes and 77.8% of the time for ultra-light cigarettes

KOZLOWSKI PUBLICATIONS ON METHODS (1994)

- 158 cigarettes from outdoor ashtrays on an American college campus
- Filter stain methodology
- "light" cigarettes: 8 – 12 mg FTC tar; 85% from one cigarette brand

Completely blocked	27%
Partially blocked	26%
Unblocked	47%



KOZLOWSKI PUBLICATIONS ON METHODS (1996)

- Random digit dialing phone survey of 788 smokers in the U.S.
- 218 ultra-low; 316 light; 210 regular
- 39 – 47% neither seen nor heard about filter vents
- Conclusion: >67% unaware of vents or consequences of blocking vents
- 10% (ultra-low and light) – 18% (regular) knew; 41 -- 51% (of 10%) used fingers; 16 – 36% (of 10%) used tape; 0 – 7% used lips

KOZLOWSKI PUBLICATIONS ON METHODS (1996) (cont.)

Fingers	49 smokers
Tape	34 smokers
Lips	7 smokers

- 788 total smokers in study; ~96 knew about vents

KOZLOWSKI PUBLICATIONS ON METHODS (1996)

- "...the stain pattern technique is best suited to detect presence versus absence of vent blocking rather than the extent of vent blocking."
- Supported by work of Helms (1983, 1984), which demonstrated that filter stain pattern depended on degree of ventilation, number and size of holes, number of rows, depth of holes



BAKER AND LEWIS CONCLUSION

- "...the presence or absence of a distinctive "bull's eye" staining pattern, as used by Kozlowski and co-workers, is not necessarily related to the incidence of vent blocking."



VIDEO-TAPED OBSERVATIONS

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FERRIS PUBLICATION (1983)

- 3 British cities; 133 smokers; £3 recompense
- One-on-one interviews conducted by psychologists from University of Wales
- *(137 interviews: three would not smoke; one refused to be taped)*



FERRIS PUBLICATION (1983) (cont.)

- 798 puff assessed; omit lighting puff
- 81% of total puffs: no finger contact
- 64% of final puffs: no finger contact
- 12% of puffs included finger contact for part or all of puff; 26% during final puff
- 10% could not be determined from the video



FERRIS PUBLICATION (1983) (cont.)

- 15% had fingers in contact for one or more puffs
- 4% had fingers in contact for all puffs
- "fingers in contact" does not necessarily mean with vent hole region
- Systematic interview data in accord Kozlowski findings, but contrary to observed behavior *with respect to finger blocking.* (emphasis in original)



BAKER AND LEWIS CONCLUSION

- “What subjects do and what they *think* they do in this case are quite different.”
(emphasis in original)



MOUTH INSERTION DEPTH STUDIES

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METHODS FOR EVALUATING INSERTION DEPTH

- Lipstick prints (presumably limited to females)
- Detection of α -amylase in dried saliva
- Detection of amino acids in dried saliva
- Measurement from television screen when replaying videotapes



RESULTS FROM MOUTH INSERTION DEPTH STUDIES

- Mean values between 10.1 and 11.5 mm (excludes videotaped measurements)
- Range 3 – 25 mm
- Insertions depth not seen to differ between ventilated and non-ventilated cigarettes
- Relatively constant over 20 years and across four countries
- Average difference between max and min for a given smoker = 3 – 5 mm in a given puff

CALCULATED VENT BLOCKING BASED ON MOUTH INSERTION DEPTH MEASUREMENTS

- Based on 1997 Canadian insertion depth distribution of 2232 butts

	% Smokers Achieving		
Vent Zone Position (mm)	No	Partial	Complete
10	53	39	8
12	72	25	3
14	84	15	1
18	97	3	0



RESULTS OF IMAGE ANALYSIS OF LIP IMPRINTS (unpublished results, 1997)

- Study by Röper of Reemtsma
- Maximum ventilation hole coverage in a given puff is ~50% for those smokers who cover the vents

EFFECTS OF PARTIAL BLOCKING ON CIGARETTE VENTILATION AND MAINSTREAM YIELDS



OVERVIEW OF RELEVANT PHYSICS

- Non-linear relationship between air flow through perforated paper and the pressure drop across the paper (6 ref)
- Relationship between filter ventilation and effective air permeability of the filter ventilation zone is non-linear
- Effective air permeability of ventilation zone depends on number of holes
- Relationship between degree of blocking and filter ventilation is non-linear




MORE PHYSICS

- Non-linearity increases as filter ventilation increases: Blocking 50% of the holes of a 20% ventilated filter reduces the ventilation from 20% to 12% (40% reduction), but blocking 50% of the holes of a 90% ventilated filter reduces the ventilation from 90% to only about 81% (10% reduction)



ESTIMATE OF MAXIMUM VENTILATION HOLE COVERAGES

- Lips and fingers
- Maximum coverage by lips in a given puff: 50%
- Maximum coverage by fingers: 25%



ESTIMATE OF MAXIMUM VENTILATION HOLE COVERAGES: WORST CASE

Zero Blockage Condensate Yield	Max Finger Blockage Condensate Yield	Max Lip Blockage Condensate Yield
1.3 (TPM)	1.6	2.5
2.2 (tar)	2.9	3.5
6.7 (tar)	7.4	8.1